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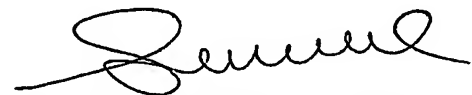
This is to certify that the annexed is a true copy of following application as filed with the Registry.

Date of Filing : 14 OCT 2002

Application Number : 200206254-5

Applicant(s) /
Proprietor(s) of Patent : AURIGIN TECHNOLOGY PTE LTD

Title of Invention : AN APPARATUS AND METHOD FOR
FILLING A BALL GRID ARRAY TEMPLATE



Sandra Lynn Merinda (Ms)
Assistant Registrar
for REGISTRAR OF PATENTS
SINGAPORE

30 OCT 2003



**PRIORITY
DOCUMENT**

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INTELLECTUAL PROPERTY OFFICE OF SINGAPORE
REQUEST FOR THE GRANT OF A PATENT UNDER
SECTION 25

101101

* denotes mandatory fields

1. YOUR REFERENCE*

10021SG2/GM/TSN/sng

2. TITLE OF
INVENTION*

AN APPARATUS AND METHOD FOR FILLING A BALL GRID
ARRAY TEMPLATE

3. DETAILS OF APPLICANT(S)* (see note 3)

Number of applicant(s)

1

(A) Name

AURIGIN TECHNOLOGY PTE LTD

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#07-09, TECHplace 1
Singapore 569626

State

Country

SG

☒

For corporate applicant

☐

For individual applicant

State of incorporation

State of residency

Country of incorporation

SG

Country of residency

☐

For others (please specify in the box provided below)

(B) Name

Address

State

Country



☐ For corporate applicant

State of Incorporation

☐ For individual applicant

State of residency

Country of Incorporation

Country of residency

☐ For others (please specify in the box provided below)

(C) Name

Address

State

Country

☐ For corporate applicant

☐ For individual applicant

State of Incorporation

State of residency

Country of Incorporation

Country of residency

☐ For others (please specify in the box provided below)

☐

Further applicants are to be indicated on continuation sheet 1

4. DECLARATION OF PRIORITY (see note 5)

A. Country/country designated

DD MM YYYY

File number

Filing Date

B. Country/country designated

DD MM YYYY

File number

Filing Date

☐

Further details are to be indicated on continuation sheet 6

5. INVENTOR(S)* (see note 6)

A. The applicant(s) is/are the sole/joint inventor(s)

Yes

☐

No

☒

200206254-5
14 OCT 2002

B. A statement on Patents Form 8 is/will be furnished

Yes

☒

No

☐

6. CLAIMING AN EARLIER FILING DATE UNDER (see note 7)

☐

section 20(3)

☐

section 26(6)

☐

section 47(4)

Patent application number

DD MM YYYY

Filing Date

Please mark with a cross in the relevant checkbox provided below
(Note: Only one checkbox may be crossed.)

☐

Proceedings under rule 27(1)(a)

DD MM YYYY

Date on which the earlier application was amended

☐

Proceedings under rule 27(1)(b)

7. SECTION 14(4)(C) REQUIREMENTS (see note 8)

Invention has been displayed at an international exhibition. Yes

☐

No

☒

8. SECTION 114 REQUIREMENTS (see note 9)

The invention relates to and/or used a micro-organism deposited for the purposes of disclosure in accordance with section 114 with a depository authority under the Budapest Treaty.

Yes

☐

No

☒

9. CHECKLIST*

(A) The application consists of the following number of sheets

i. Request

5

Sheets

ii. Description

8

Sheets

iii. Claim(s)

3

Sheets

iv. Drawing(s)

8

Sheets

v.

Abstract
(Note: The figure of the drawing,
if any, should accompany the
abstract)

1

Sheets

Total number of sheets

25

Sheets

(B) The application as filed is accompanied by:

☐

Priority document(s)

☐

Translation of priority document(s)

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14 OCT 2002

☒ Statement of inventorship
& right to grant

☐ International exhibition certificate

DETAILS OF AGENT (see notes 10, 11 and 12)

e

Ella Cheong Mirandah & Spruons Pte Ltd

ADDRESS FOR SERVICE IN SINGAPORE* (see note 10)

k/Hse No.

Level No.

Unit No./PO Box

1531

et Name

ding Name

Robinson Road Post Office

tal Code

903031

NAME, SIGNATURE AND DECLARATION (WHERE APPROPRIATE) OF APPLICANT OR AGENT* (see note 12)
le: Please cross the box below where appropriate.)

☒ I, the undersigned, do hereby declare that I have been duly authorised to act as representative, for the purposes of this application, on behalf of the applicant(s) named in paragraph 3 herein.

Ella Cheong Mirandah & Spruons Pte Ltd

Name and Signature

DD MM YYYY

14 10 02

NOTES:

1. This form when completed, should be brought or sent to the Registry of Patents together with the rest of the application. Please note that the filing fee should be furnished within the period prescribed.
2. The relevant checkboxes as indicated in bold should be marked with a cross where applicable.
3. Enter the name and address of each applicant in the spaces provided in paragraph 3.
Where the applicant is an individual
 - Names of individuals should be indicated in full and the surname or family name should be underlined.
 - The address of each individual should also be furnished in the space provided.
 - The checkbox for "For individual applicant" should be marked with a cross.
Where the applicant is a body corporate
 - Bodies corporate should be designated by their corporate name and country of incorporation and, where appropriate, the state of incorporation within that country should be entered where provided.
 - The address of the body corporate should also be furnished in the space provided.
 - The checkbox for "For corporate applicant" should be marked with a cross.
Where the applicant is a partnership
 - The details of all partners must be provided. The name of each partner should be indicated in full and the surname or family name should be underlined.
 - The address of each partner should also be furnished in the space provided.
 - The checkbox for "For others" should be marked with a cross and the name and address of the partnership should be indicated in the box provided.
4. In the field for "Country", please refer to the standard list of country codes made available by the Registry of Patents and enter the country code corresponding to the country in question.
5. The declaration of priority in paragraph 4 should state the date of the previous filing, the country in which it was made, and indicate the file number, if available. Where the application relied upon in an International Application or a regional patent application e.g. European patent application, one of the countries designated in that application [being one falling under section 17 of the Patents Act] should be identified and the country should be entered in the space provided.
6. Where the applicant or applicants is/are the sole inventor or the joint inventors, paragraph 5 should be completed by marking with a cross the 'YES' checkbox in the declaration (A) and the 'NO' checkbox in the alternative statement (B). Where this is not the case, the 'NO' checkbox in declaration (A) should be marked with a cross and a statement will be required to be filed on Patents Form 8.
7. When an application is made by virtue of section 20(3), 26(6) or 47(4), the appropriate section should be identified in paragraph 6 and the number of the earlier application or any patent granted thereon identified. Applicants proceeding under section 26(6) should identify which provision in rule 27 they are proceeding under. If the applicants are proceeding under rule 27(1)(a), they should also indicate the date on which the earlier application was amended.
8. Where the applicant wishes an earlier disclosure of the invention by him at an International Exhibition to be disregarded in accordance with section 14(4)(c), then the 'YES' checkbox at paragraph 7 should be marked with a cross. Otherwise, the 'NO' checkbox should be marked with a cross.
9. Where in disclosing the invention the application refers to one or more micro-organisms deposited with a depository authority under the Budapest Treaty, then the 'YES' checkbox at paragraph 8 should be marked with a cross. Otherwise, the 'NO' checkbox should be marked with a cross. Attention is also drawn to the Fourth Schedule of the Patents Rules.
10. Where an agent is appointed, the fields for "DETAILS OF AGENT" and "ADDRESS FOR SERVICE IN SINGAPORE" should be completed and they should be the same as those found in the corresponding Patents Form 41. In the event where no agent is appointed, the field for "ADDRESS FOR SERVICE IN SINGAPORE" should be completed, leaving the field for "DETAILS OF AGENT" blank.
11. In the event where an individual is appointed as an agent, the sub-field "Name" under "DETAILS OF AGENT" must be completed by entering the full name of the individual. The sub-field "Firm" may be left blank. In the event where a partnership/body corporate is appointed as an agent, the sub-field "Firm" under "DETAILS OF AGENT" must be completed by entering the name of the partnership/body corporate. The sub-field "Name" may be left blank.
12. Attention is drawn to sections 104 and 105 of the Patents Act, rules 90 and 105 of the Patents Rules, and the Patents (Patent Agents) Rules 2001.
13. Applicants resident in Singapore are reminded that if the Registry of Patents considers that an application contains information the publication of which might be prejudicial to the defence of Singapore or the safety of the public, it may prohibit or restrict its publication or communication. Any person resident in Singapore and wishing to apply for patent protection in other countries must first obtain permission from the Singapore Registry of Patents unless they have already applied for a patent for the same invention in Singapore. In the latter case, no application should be made overseas until at least 2 months after the application has been filed in Singapore, and unless no directions had been issued under section 33 by the Registrar or such directions have been revoked. Attention is drawn to sections 33 and 34 of the Patents Act.
14. If the space provided in the patents form is not enough, the additional information should be entered in the relevant continuation sheet. Please note that the continuation sheets need not be filed with the Registry of Patents if they are not used.

TITLE OF THE INVENTION

AN APPARATUS AND METHOD FOR FILLING A BALL GRID ARRAY
TEMPLATE

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BACKGROUND OF THE INVENTION

Field of the invention

The present invention generally relates to ball grid array (BGA) and in particular, an apparatus and method for filling a ball grid array template with solder balls.

Description of the Prior Art

Ball grid arrays techniques are common nowadays for connecting high-density IC components onto circuit boards. US Patent No. 5,655, 704, issued to Matsushita Electric Industrial Co., 12 August 1997 discloses a method of filling a template or a stencil with solder balls as a sweeping bin passes over the template. However, such method is very susceptible to solder ball damage by the design itself as well as due to process variability, contamination or foreign particle. As a result of the damage, subsequent process becomes not possible or the object of subsequent depositing the solder ball on the BGA package is not possible.

FIG. 1 shows a conventional method of filling a BGA template with solder balls. The BGA template 1 is provided with a plurality of holes to receive a plurality of solder balls 3. A ball bin 2 sweeps over and above the template 1 and deposits the solder balls 3 into the holes on the template 1. As this deposition of the solder balls 3 can happen anytime when the solder ball 3 and the hole are aligned, the deposition may take place just as the ball bin 2 is about to reach the particular hole at which the solder ball 4 is just about to drop in. As shown in FIG. 1, this may result in the ball 4 being quashed by the bin 2. Another possible situation is when the solder ball 6 fails to properly seat in the hole due to foreign matter 5. The bin 2 will shear off the top of the solder ball 6.

FIG. 2 is a perspective view showing a solder ball mounting apparatus disclosed in US Patent No. 5,655, 704. As shown in the FIG. 2, the solder balls are deposited onto the substrate 10 through the stencil 7. The flux dots 11 on

the substrate hold the solder balls 9 in place. However, as these flux dots 11 are liquid paste, the volume or height of the dot 11 may vary as in the case of flux dot 12, where there is excessive amount. This causes the solder ball 13 to stick out of the stencil 7 and be sheared off at the top as the solder ball bin 8 passes over the ball 13. There can potentially be cases where there is not any flux dots and the solder balls will drop lower than the usual height and the solder ball 14 will be sheared by the bin 8.

US Patent No. 5,499,487, issued to Vanguard Automation, Inc., 19 March 1996 discloses an apparatus for placing solder balls in a ball grid array. The apparatus comprises a wheel having an inner and an outer face, and the wheel being rotatable about a horizontal axis, means for attaching a ball grid array to the inner face of the wheel, means for attaching a tooling fixture to the outer face of the wheel in a position corresponding to that of the ball grid array, means for forming a reservoir of solder balls at the bottom of the wheel, means for controllably rotating the wheel to move the tooling fixture through the reservoir in a manner to fill recesses in the fixture with solder balls and to remove from the surface of the array any excess solder balls which are not occupying recessed, the inner and the outer faces being separated a distance to permit the tooling fixture to engage solder balls in the reservoir while ball grid array does not engage the solder balls.

US Patent No. 5,551,216 relates to a method and apparatus for filling a ball grid array. The apparatus comprises a reservoir for solder balls and a tooling plate with an array of holes for receiving solder balls. US Patent No. 6,276,598 relates to a method and an apparatus for ball placement. The method and apparatus are particularly suitable for transferring solder balls to a ball grid array package.

The methods disclosed in the above US Patents Nos. 5,499,487, 5,551,216, and 6,276,598 make use of free flow of solder balls 17 over tilted templates 15 with or without vacuum suction at the holes receiving the solder balls. This method does not prevent excess solder balls 18 and solder balls 19 remaining on the surface of the template or around the holes due to either static forces, vacuum leakage at holes or foreign matter which may be sticky like flux

used in the attachment to the substrate. In these citations, subsequent operation whereby the ball pick head 16 or a ball grid array substrate 20 is advanced above the template will result in quashed solder ball or multiple balls at each hole in the pick head or at each electrode on the ball grid array (as shown in
 5 FIGS. 3 and 4).

US Patent No. 5,918,792, issued to RSVI Vanguard, Inc., 6 July 1999, discloses ball grid arrays and method for placement of solder balls onto the pattern of metallized pads or dots of such arrays. The apparatus comprises an elongated holder defining an elongated recess therein for the carrier of the array,
 10 a stencil overlying the recess and supported by guide rails, a block of rigid material having a planar bottom surface contacting the stencil and for movement along the stencil, and means for moving the block along the stencil for moving a bin contacting solder balls over the apertures formed on the stencil for filling the apertures.

15 SUMMARY OF THE PRESENT INVENTION.

Accordingly it is an object of the present invention to provide an apparatus and method for filling a ball grid array template with solder balls. Yet another object of the present invention is to provide an apparatus for filling a
 20 ball grid array template having locating holes with a plurality of small solder balls comprising

a base plate rotatably mounted at the axis thereof to a controlling device and the ball grid array template being mounted onto the base plate so that the template rotates simultaneously with the base plate;

25 a ball supply bin slidably mounted over the top surface of the base plate while being rotated together with the base plate, the sliding motion of the ball supply bin being controlled by a driving means such as a motor, and the ball grid array template about the axis of the base plate, and the ball supply bin being substantially rectangular and enclosed on three vertical sides while the fourth
 30 vertical side proximity to the ball grid array template being a ball gate, said ball gate pivoted about the axis thereof and being normally rested by a stop pin or the like, such as a stopping edge, positioned at the lower surface of the ball gate;

a sensing device positioned at both the ends of the base plate at a height similar to the height of the ball gate from the base plate for monitoring the opened/closed position of the ball gate; and

a plurality of small solder balls enclosed by the ball supply bin
5 thereby when the base plate tilted towards the ball grid array template, the bin supply bin slides to and over the ball grid array template and thereby fill up the locating holes on the template with solder balls, the base plate is then tilted in the opposite direction, the ball supply bin slides back to the other end and simultaneously, the excess solder balls are fallen back with the supply bin.

10 Yet a further object of the present invention is to provide a method of filling solder balls on a ball grid array template having a plurality of locating holes, said method comprising the steps of:

positioning said ball grid array template at one end of a pivotal base plate;

introducing a plurality of solder balls in a ball supply bin which is slidably
15 positioned at the one end of the base plate, and is slidable on the base plate;

clockwise rotating of the base plate, causing the ball supply bin sliding towards the ball grid array template to allow the solder balls contained in the ball supply bin to fill the locating holes on the template, and the sliding motion of the ball supply bin being controlled by a driving means such as a motor, each
20 solder ball for each locating hole; and

counter-clockwise rotating of the base plate and sliding of the ball supply bin back to its initial position and, in so doing, remove any excess solder balls from above the ball grid array template.

A further object of the present invention is to provide an apparatus for
25 filling solder balls on a ball grid array template, further comprising a ball pick head which is lowered above the ball grid template to remove the solder balls by vacuum for transferring to a ball grid array substrate.

Yet another object of the present invention is to provide a method of filling solder balls on a ball grid array template, wherein the base plate is tilted
30 clockwise in an angle ranging from 5 to 40 degree above horizontal.

Yet another object of the present invention is to provide a method of removing excess solder balls from a ball grid array template, wherein the base plate is tilted anti-clockwise in an angle ranging from 20 to 75 degree.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partly enlarged cross-sectional view showing a conventional solder ball mounting apparatus.

10 FIG. 2 is a cross-sectional view of another conventional solder ball mounting apparatus.

FIGS. 3 and 4 schematically show instances which may result in quashed solder ball or multiple balls at each hole in the pick head or at each electrode on the ball grid array in a conventional solder ball mounting apparatus.

15 FIG. 5 is a cross-sectional view showing the depositing of solder balls from the ball supply bin to the ball array template in accordance with the present invention.

FIGS. 6 to 15 are cross-sectional views showing operation sequence of depositing of solder balls in accordance with the present invention.

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DETAILED DESCRIPTION OF THE PRESENT INVENTION

While the specification concludes with claims defining the features of the invention that are regarded, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawings.

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Referring now to FIG. 5, there is shown an apparatus for filling solder balls on a ball grid array template in accordance with the present invention. The apparatus comprises a base plate 1 rotatably mounted at the axis 2 thereof to a controlling device; a ball grid array template 3 mounted onto the top surface of the base plate 1 at one end thereof so that the ball grid array template 3 rotates simultaneously with the base plate 1 when the base plate 1 rotates (tilts) clockwise or anti-clockwise; a ball supply bin 4 substantially rectangular shape

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slidably mounted over the top surface of the base plate 1 at the other end thereof and corresponding to the position of the ball grid array template 3 and the ball supply bin is driven by a motor and is moveable along the base plate 1 while the base plate 1 rotates about the axis 2 of the base plate 1. In accordance with the present preferred embodiment, the ball supply bin 4 is enclosed on three vertical sides while the fourth vertical side, proximity to the ball grid array template 3, is provided with a ball gate 5. The ball gate 5 is pivoted about the axis 6 thereof and is normally rested by a stop pin 7 positioned at the lower surface of the ball gate 5 when the base plate 1 rotates clockwise or counter-clockwise. The ball grid array template 3 is provided with a plurality of locating holes 12 on the top surface to hold solder balls 10, and one locating hole 12 receives only one solder ball 10, as shown in FIG. 5.

A sensing device 8, such as a through-beam sensor, or a focused-beam reflective sensor is positioned and supported at both the ends of the base plate 1 at a height similar to the height of the ball gate 5 from the base plate 1 for monitoring the opened/closed position of the ball gate 5. If the ball gate 5 is in an open position, this indicates an abnormality in operation. The ball gate 5 is designed in such a way that the weight of the ball gate 5 is pivoted about the axis 6 and the weight will ensure that the ball gate 5 forms a close wall to contain the solder balls 11 within the ball supply bin 4.

As shown in FIG. 5, a plurality of small solder balls (in bulk) 11 are enclosed by the ball supply bin 4. A ball pick head 9 is positioned above the ball template 3 and is lowered to remove the solder balls 10 on the ball grid array template 3 by vacuuming for transferring to a BGA substrate 19 (referring to FIG. 15).

In accordance with the present invention, a vacuum 18 is provided to a chamber 13 underneath the ball grid array template 3, in communication with the individual locating holes 12 on the ball grid array template 3 so as to assist the filling of the solder balls 10 (referring to FIG. 7 and FIG. 8).

FIGS. 7 through 15 depict the operation of the apparatus in accordance with the present invention.

At the initial operation of the apparatus, the base plate 1 together with the ball grid array template 3 having no solder balls 10 on the locating holes 12 are in the horizontal position (as shown in FIG. 6). As shown in FIG. 6, the solder balls 11 are contained within the ball supply bin 4 and the ball gate 5 is at the close position.

Referring to FIG. 7, the base plate 1 tilts or is rotated clockwise to about 5 to 40 degree above horizontal. The angle of rotation is determined by the ability of the solder balls 11 within the ball supply bin 4 to spread out towards the ball gate 5 to maximize ball deposition possibility over the ball grid array template 3 in subsequent steps. The ball gate 5 forms a close wall to keep the solder balls 11 within the supply bin 4.

As shown in FIG. 8, the ball supply bin 4 slides towards the ball grid array template 3 and over the template 3 and in so doing, the solder balls 11 within the supply bin 4 are deposited into the locating holes 12 on the surface of the template 3. The vacuuming means 18 connected to the chamber 13 assist in filling the solder balls 10 into the locating holes 12 on the template 3.

Referring to FIG. 9, the base plate 1 is then tilted or rotated counter-clockwise to about 20 to 75 degree below horizontal. Similarly, the angle of rotation is determined by the ability of the solder balls 11 within the ball supply bin 4 to fall freely by gravity towards the far-end of the bin 4 from the ball gate 5 and by the amount of rotational torque balance at which the ball gate 5 is pivoted about the axis 6.

Due to the fact that the solder balls 11 are typically very small, as small as 0.2 mm diameter, some residual solder balls, denoted as 14, may attach to the surfaces 15 of the base plate 1, the ball grid array template 3 or around the locating holes 12 due to static charges, humidity, contamination or vacuum leakage.

As shown in FIG. 10, at this angular orientation, the ball supply bin 4 slides backwards and in so doing sweeps off excess residual solder balls 14. The solder balls 10 deposited in the locating holes 12 remains in place, held by either vacuum 18 in the chamber 13 or by the depth of the locating holes 12.

At the end of sliding movement of the ball supply bin 4, the locating holes 12 shall be fully deposited in such a way that only one solder ball 10 is contained in each locating holes 12. However, in an abnormal situation, as shown in FIG. 11, whereby the residual solder ball 14 remains firmly stuck onto the surrounding area of the locating holes 12, the ball gate 5 will be tilted counter clockwise and the tilting of the ball gate 5 is detected by the sensor 8.

FIG. 12 shows another abnormal situation where the residual solder balls 14 are stuck. As shown in the figure, the solder ball 14 is not seated properly in the locating hole 12 in the ball grid array template 3. This can possibly be due to foreign matter 16 present in the locating hole 12, and the ball gate 5 will be triggered as the ball gate 5 reaches this abnormal location and the abnormal situation will be detected by the sensor 8.

In accordance with the present invention, the center of gravity of the ball gate 5 is offset from the pivot axis 6 thereof so that the sensitivity of the ball gate 5 in detecting abnormalities and yet not damage solder balls 14 can be adjusted by the amount of rotation of the base plate 1, as shown in FIGS. 11 and 12.

As shown in FIG. 13, the base plate 1 has restored to a horizontal position, and under normal operation, the base plate 1 is rotated clockwise back to its initial position, whereby the solder balls 10 in the locating holes 12 on the ball grid array template 3 is in a suitable position for further semiconductor packaging processes.

FIG. 14 shows an example of further processes. The ball pick head 9 of the semiconductor packaging device (not shown) is lowered above the ball grid array template 3 to remove the positioned solder balls 10 by vacuum 17 for transfer to ball grid array substrate 19, shown in FIG. 15.

While certain novel features of this invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated and in its application can be made by those skilled in the art without departing from the spirit of the invention.

CLAIMS

1. An apparatus for filling a ball grid array template having locating holes
5 with a plurality of small solder balls comprising
a base plate rotatably mounted at the axis thereof to a controlling device
and the ball grid array template being mounted onto the base plate so that the
template rotates simultaneously with the base plate;
a ball supply bin slidably mounted over the top surface of the base plate
10 while being rotated together with the base plate, the sliding motion of the ball
supply bin being controlled by a driving means, and the ball grid array template
about the axis of the base plate, and the ball supply bin being substantially
rectangular and enclosed on three vertical sides while the fourth vertical side
proximity to the ball grid array template being a ball gate, said ball gate pivoted
15 about the axis thereof and being normally rested by a stop pin or a stopping
edge, positioned at the lower surface of the ball gate;
a sensing device positioned at both the ends of the base plate at a height
similar to the height of the ball gate from the base plate for monitoring the
opened/closed position of the ball gate; and
20 a plurality of small solder balls enclosed by the ball supply bin
thereby when the base plate tilted towards the ball grid array template, the ball
supply bin slides to and over the ball grid array template and, in so doing, fills
up the locating holes on the template with solder balls, the base plate is then
tilted in the opposite direction, the ball supply bin slides back to the other end
25 and simultaneously, the excess solder balls are fallen back with the supply bin.
2. The apparatus as set forth in Claim 1, wherein the sensing device is a
through-beam sensor or a focused-beam reflective sensor.
- 30 3. The apparatus as set forth in Claim 1, wherein the base plate is tilted
clockwise in an angle ranging from 5 to 40 degree above horizontal.

4. The apparatus as set forth in Claim 1, wherein the weight of the ball gate is pivoted about the axis thereof so as to form a close wall to contain the solder balls within the ball supply bin.

5 5. The apparatus as set forth in Claim 1, wherein the locating holes on the ball grid array are connected to a vacuum to enhance filling of the solder balls thereto.

10 6. The apparatus as set forth in Claim 1, wherein the base plate is tilted anti-clockwise in an angle ranging from 20 to 75 degree.

7. The apparatus as set forth in Claim 1, further comprising a ball pick head which is lowered above the ball grid array template to remove solder balls by vacuum for transferring to a ball grid array substrate.

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8. A method of filling solder balls on a ball grid array template having a plurality of locating holes, said method comprising the steps of:

positioning said ball grid array template at one end of a pivotal base plate;
introducing a plurality of solder balls in a ball supply bin which is slidably
20 positioned at the one end of the base plate, and is slidable on the base plate;

clockwise rotating of the base plate, causing the ball supply bin which is controlled by a driving means, sliding towards the ball grid array template to allow the solder balls contained in the ball supply bin to fill the locating holes on the template, each solder ball for each locating hole; and

25 counter-clock wise rotating of the base plate, causing the ball supply bin which is controlled by the driving means driven, to slide back to the initial position of the supply bin and a plurality of solders fill the locating holes, one to each hole.

30 9. The method of Claim 8, wherein the base plate is tilted clockwise in an angle ranging from 5 to 40 degree above horizontal.

10. The method of Claim 8, wherein the base plate is tilted counter-clockwise in an angle ranging from 20 to 75 degree below horizontal.

11. The method of Claim 8, wherein the driving means is a motor.

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12. The method of Claim 8, further comprising the steps of rotating the base plate in clockwise direction to horizontal position, allowing the solder balls in the template to be transferred for further processing.

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ABSTRACT OF THE DISCLOSURE

AN APPARATUS AND METHOD FOR FILLING A BALL GRID ARRAY
TEMPLATE

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An apparatus and method for filling a ball grid array template is disclosed. The apparatus comprises a base plate rotatably mounted at the axis thereof to a controlling device and the ball grid array template being mounted onto the base plate so that the template rotates simultaneously with the base plate; a ball supply bin slidably mounted over the top surface of the base plate while being rotated together with the base plate and the ball grid template about the axis of the base plate, and the ball supply bin being substantially rectangular and enclosed on three vertical sides while the fourth vertical side proximity to the ball grid array template being a ball gate, said ball gate pivoted about the axis thereof and being normally rested by a stop pin or a like, such as a stopping edge positioned at the lower surface of the ball gate; a sensing device positioned at both the ends of the base plate at a height similar to the height of the ball gate from the base plate for monitoring the opened/closed position of the ball gate; and a plurality of small solder balls enclosed by the ball supply bin. The present invention also relates to a method of filling solder balls onto the ball grid template employed the apparatus.

(FIG. 5)

162162

FIG.1
PRIOR ART

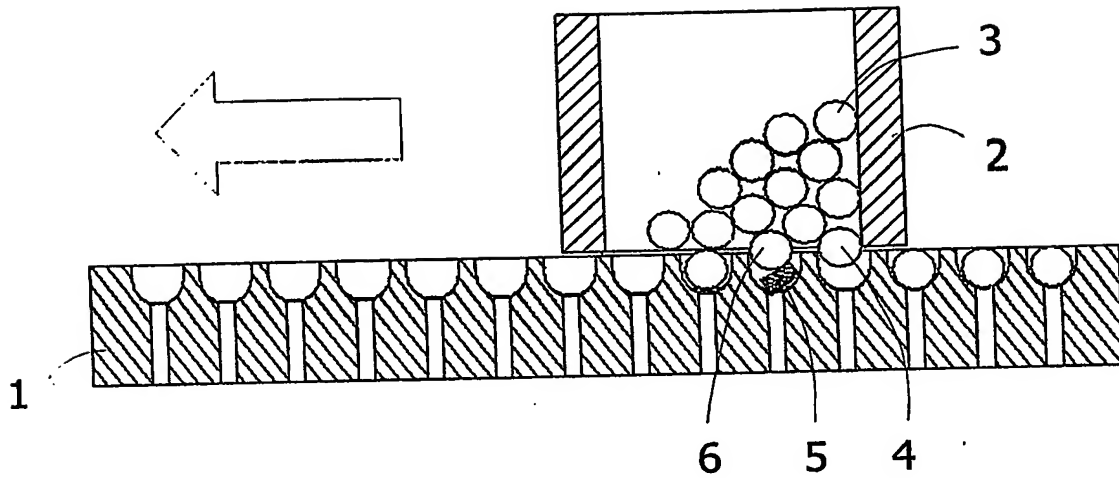


FIG.2
PRIOR ART

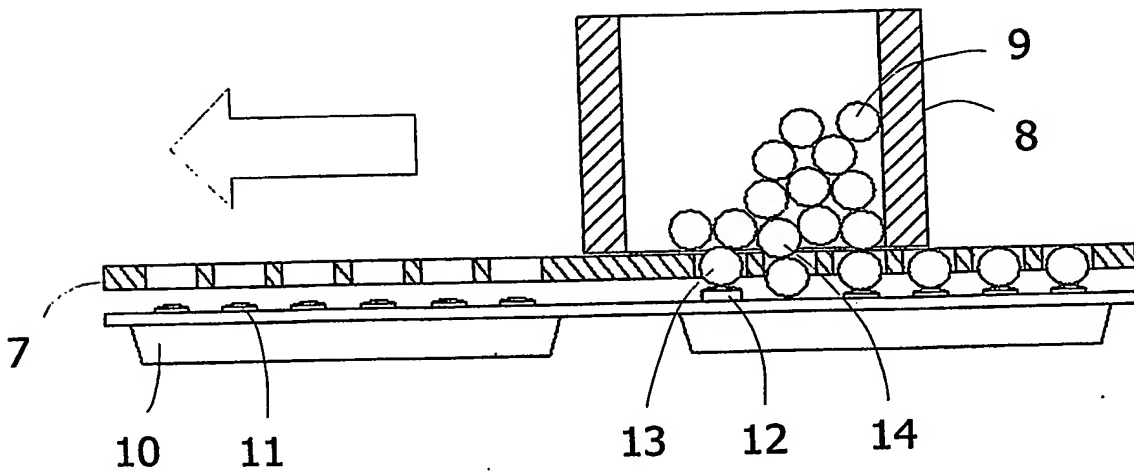


FIG.3
PRIOR ART

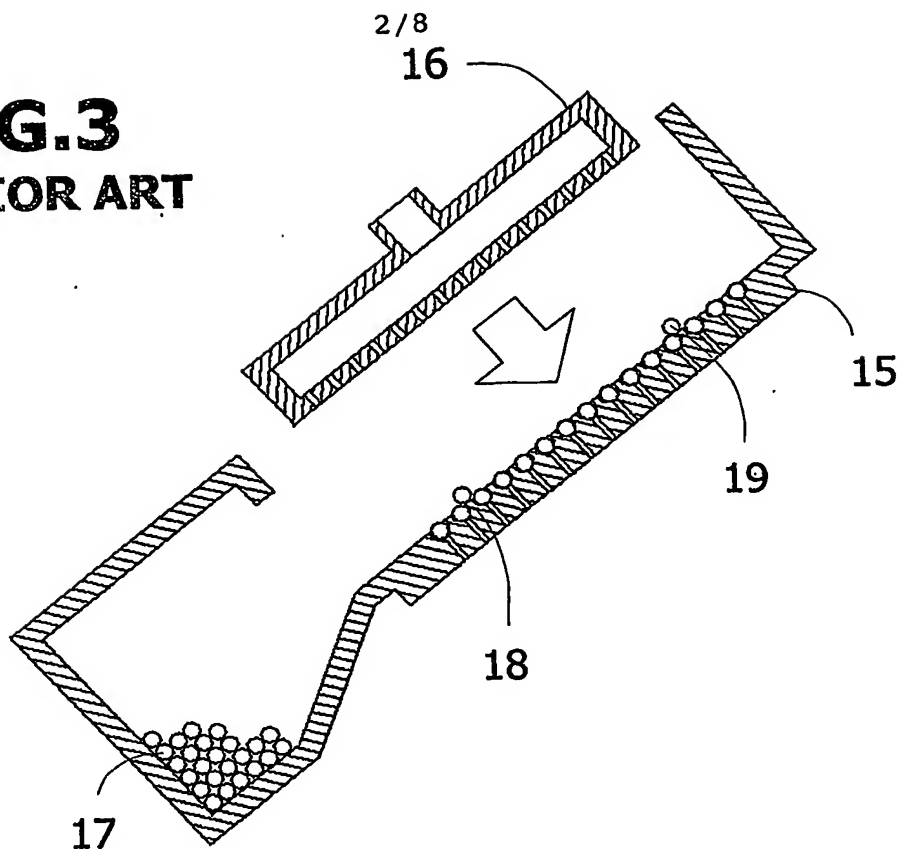


FIG.4
PRIOR ART

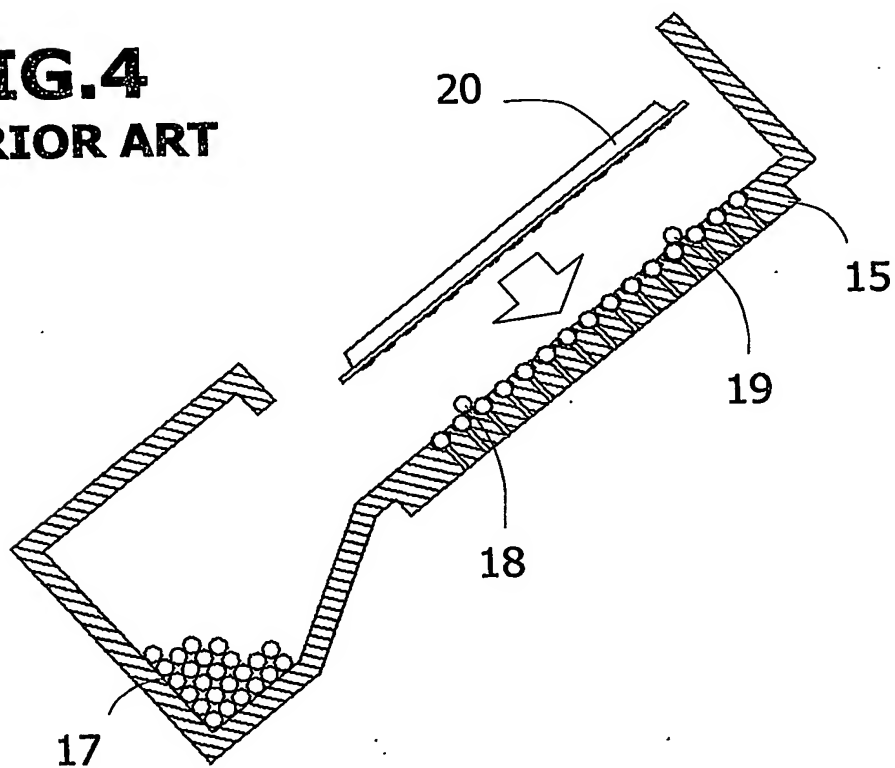


FIG.5

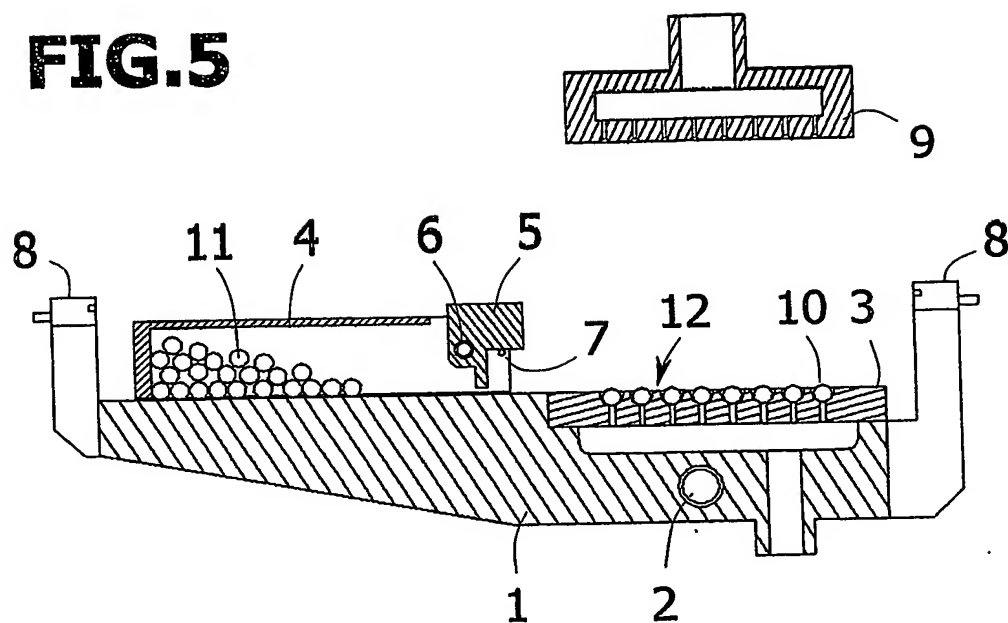


FIG.6

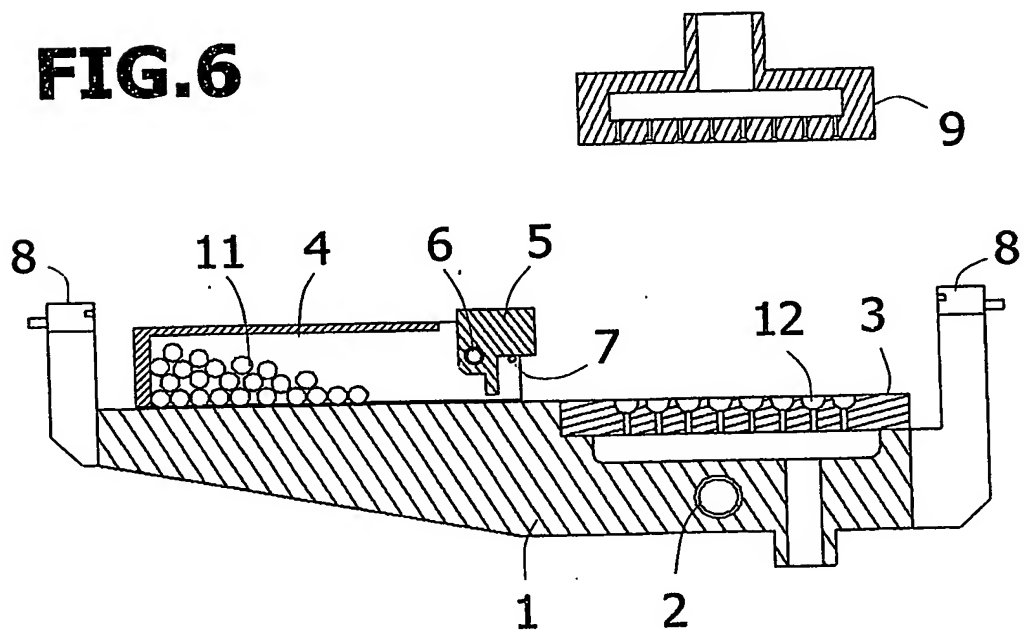


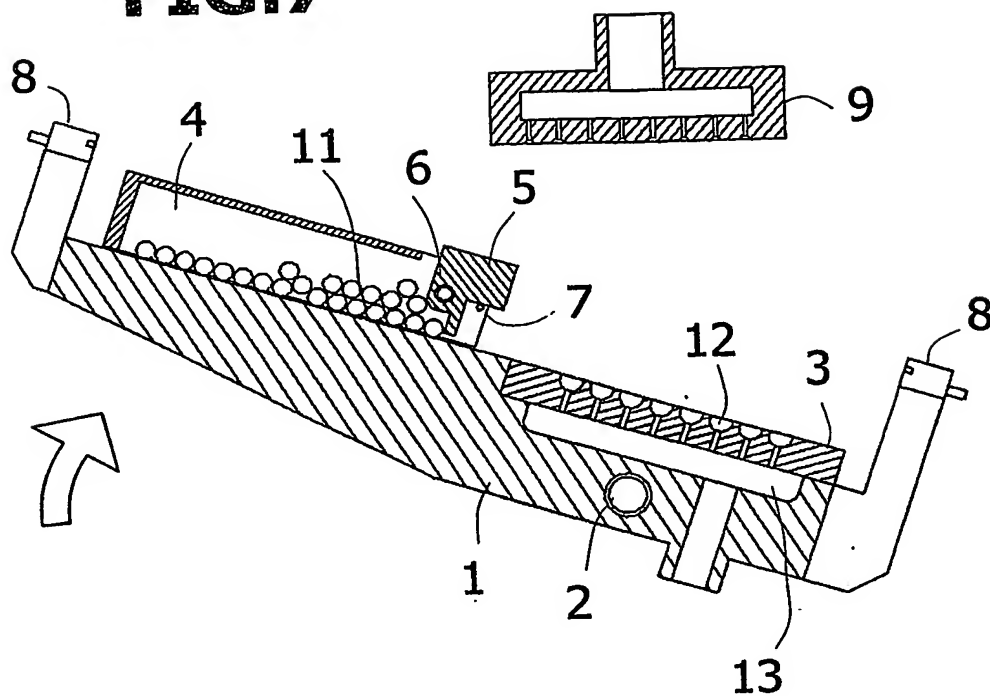
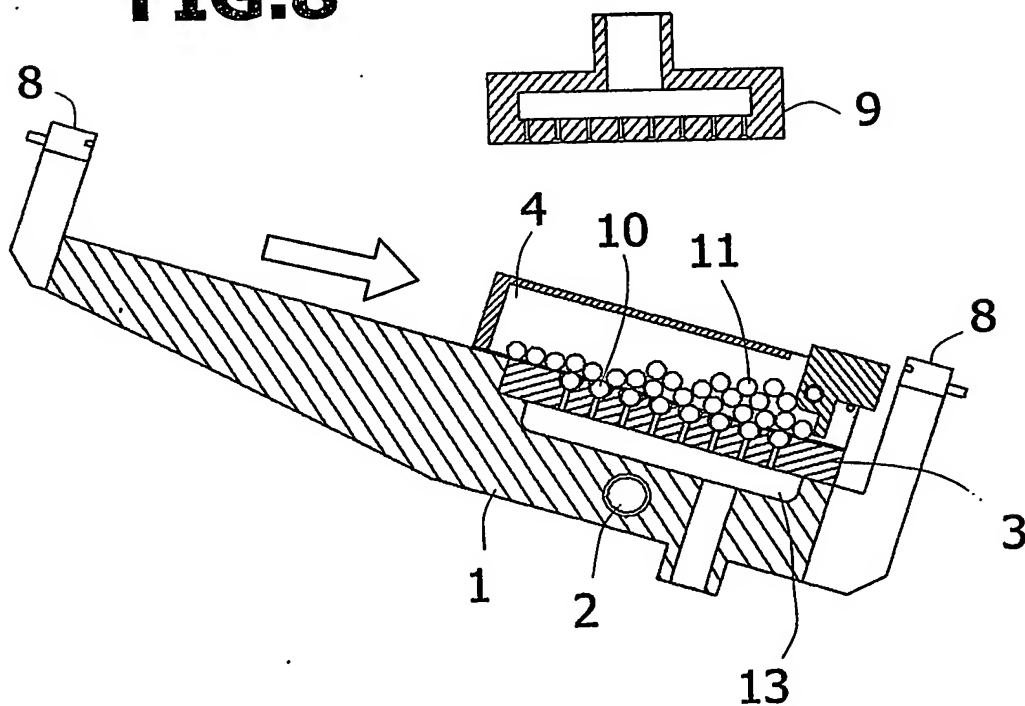
FIG.7**FIG.8**

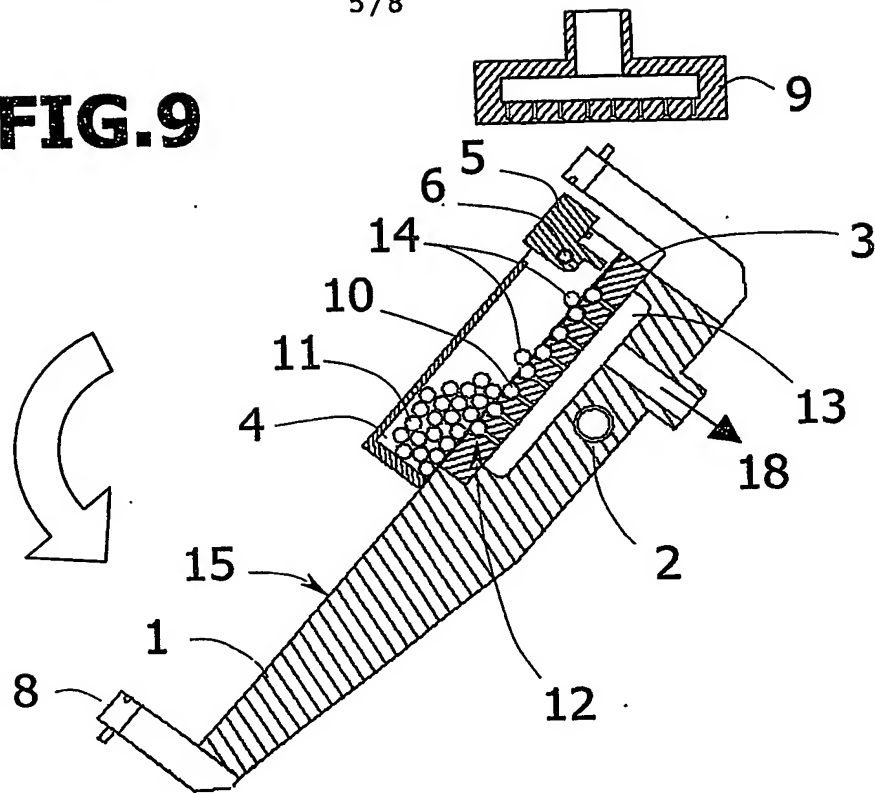
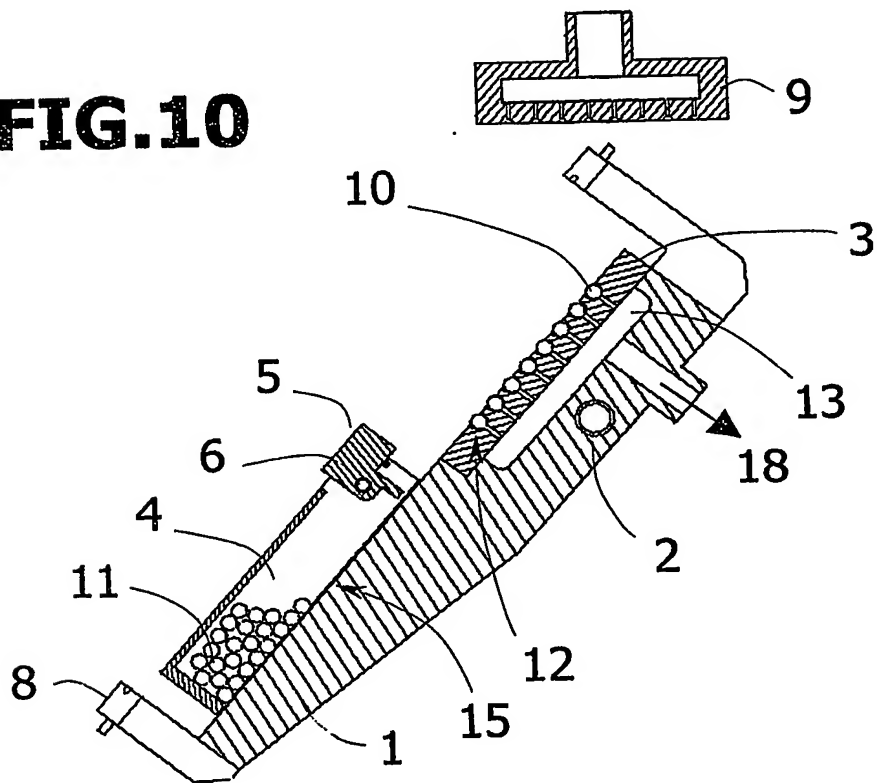
FIG.9**FIG.10**

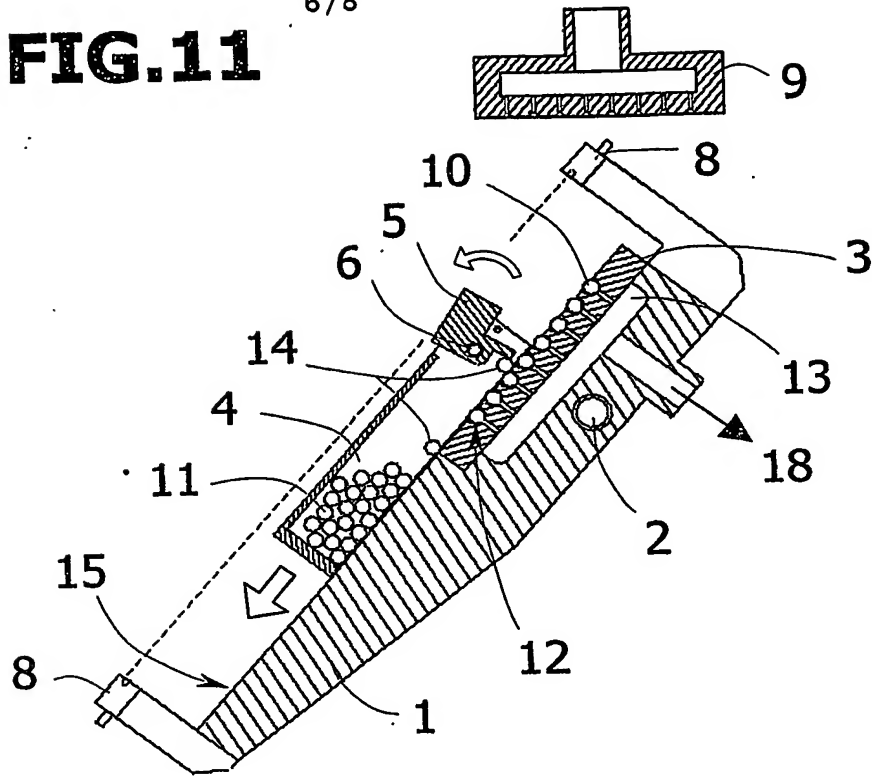
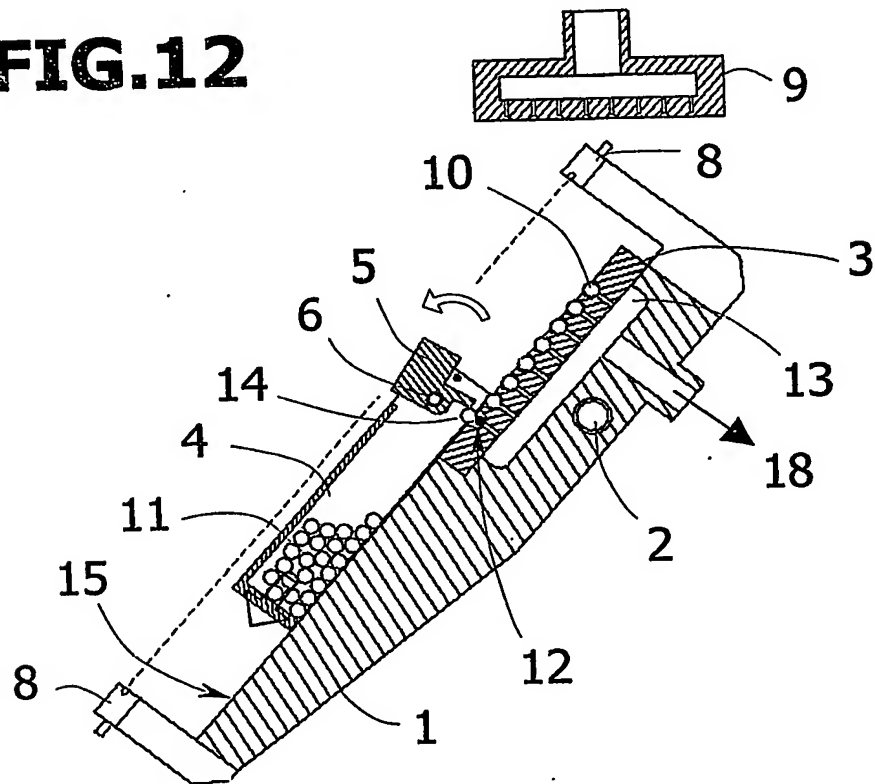
FIG.11**FIG.12**

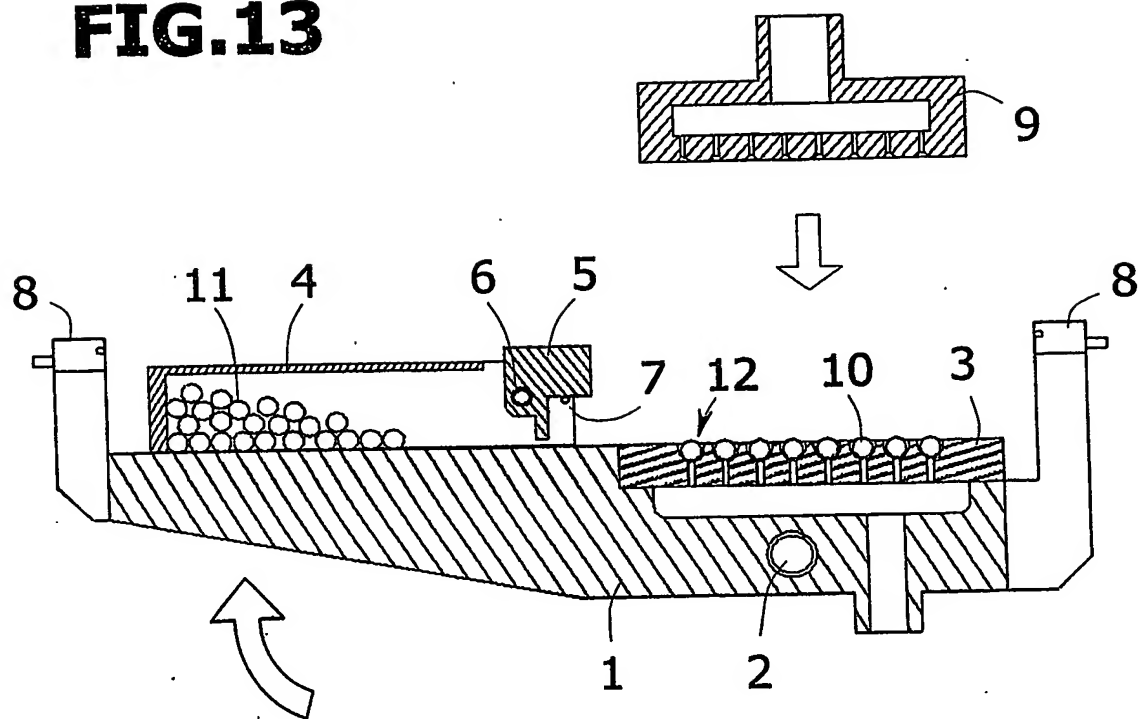
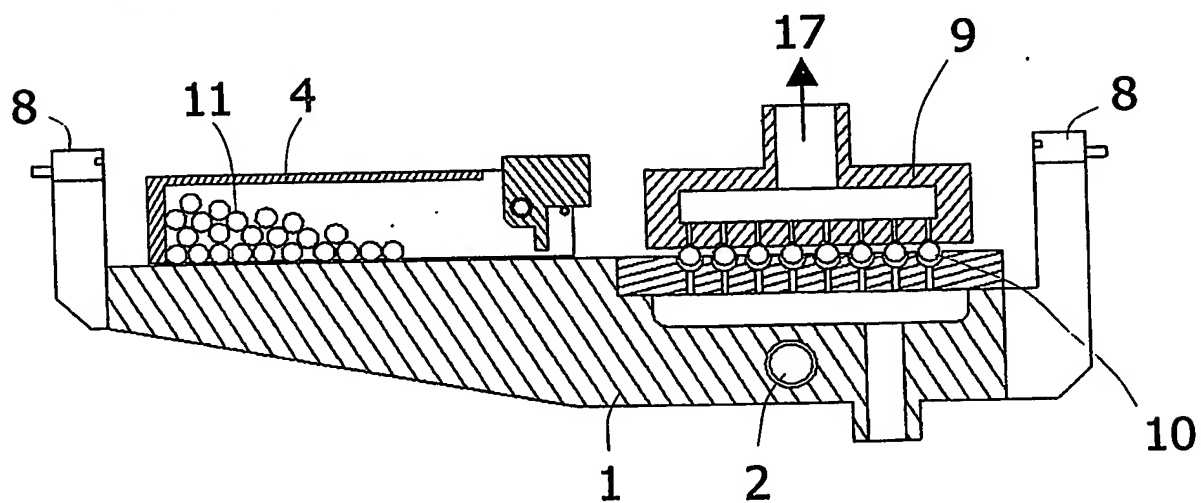
FIG.13**FIG.14**

FIG.15